

# PATENT SPECIFICATION

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## (54) IMPROVEMENTS IN OR RELATING TO GEARBOXES

(71) We, THE ENGLISH ELECTRIC COMPANY LIMITED of 1 Stanhope Gate, London W1A 1EH, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to gearboxes and particularly to the construction of gearbox casings.

In the design of large gearboxes, for example for marine applications, the axial components of driving forces between helical gears have to be taken into account. This problem can be overcome, in known manner, by forming each gear wheel and pinion with two helices of opposite hand to give what is known as a double helix gear. The axial forces then balance within the gearwheel or pinion and are not transmitted to the casing of the gearbox. However, in some circumstances the extra room that is required for such double-helix gears is not available or is at a premium, and single helix gears have to be used. Single-helix gears are also, of course, less costly to manufacture.

For some large scale applications, again for example, marine applications, it is convenient to distribute the input power to a gearbox among several input pinions, the output being taken from the shaft of a single large gearwheel. These input pinions are arranged around the gearwheel, and, like the gearwheel, their shafts are mounted in the casing of the gearbox.

The basic problem of making the gearbox casing sufficiently rigid to resist the axial thrusts of the gears is thus made more difficult by the necessity for being able to assemble and remove the various pinions in the working position.

It is an object of the present invention to provide a gearbox construction which alleviates the difficulty.

According to the present invention, in a gearbox having a single-helix driven gearwheel, a plurality of driving pinions engaging the gearwheel, and bearings for the gearwheel and pinions mounted in two opposing plate structures, each plate

structure extending as a unitary member between a bearing of the gearwheel and a bearing of each of said pinions, a stiffening plate fixed to said plate structures, extends between and parallel to the axes of the gearwheel and a said pinion, said stiffening plate having an aperture to accommodate the engagement of the gearwheel and pinion which engagement would otherwise be obstructed.

Each plate structure preferably has two walls rigidly connected by a plurality of stiffening webs. The stiffening plate preferably extends from the outer wall of one plate structure to the outer wall of the other.

The stiffening plate may extend around the gear wheel and include a respective aperture for the engagement of each of a plurality of said pinions. It may also form a part of a closure wall of the gearbox.

The stiffening plate preferably extends from a mounting base of the gearbox to the pinion most remote from the mounting base.

There may be a respective stiffening plate associated with each of two or more pinions.

The gearwheel and pinions may be removable from the plate structures in directions transverse to their axes, and means may be provided for clamping the gearwheel and pinion bearings in position in recesses in the edges of said plate structures.

A gearbox in accordance with the invention will now be described, by way of example, with reference to the accompanying drawings, of which:

Figures 1 and 2 are outside rear elevation and end view of the gearbox;

On a larger scale:

Figure 3 is a part sectional elevation 90 similar to Figure 2;

Figure 4 is a sectional plan on the line IV—IV of Figure 5; and

Figure 5 is a part sectional front elevation 95 of the gearbox.

Referring to these drawings, the gear box comprises a main casing 1 and an upper part, a cover 2, joined at the section line IV—IV in Figure 5 (and so indicated in Figure 1). This particular gearbox is for 100 marine application and provides a step-down coupling between three diesel engines

(not shown) and a ship's propeller shaft (also not shown).

The propeller shaft is directly coupled to an output flange 3 at the rear face of the gearbox as shown in Figure 1. The flange 3 is an integral part of a gearwheel shaft 4, as shown in Figure 4, the gearwheel 5 being shown in this figure and in Figure 5.

The single helix gearwheel 5 is engaged by three pinions, 6, 7 and 8 at the upper and lower starboard side and the lower port side respectively. As shown best in Figures 3 and 4, each pinion 6, 7 and 8 is formed integrally on a hollow shaft 9 through which extends a driving shaft 12. The two shafts 9 and 12 are coupled together by means of a clutch 13.

It is convenient in the particular case, in view of the disposition of the gearbox and the available room, for the clutches 13 of the lower pinions 7 and 8 to be mounted at the rear of the gearbox and the clutch 13 of the upper pinion 6 to be mounted at the front. Individual diesel engines are directly coupled to the driving shafts 12 at the opposite end from the clutch 13.

Considering now the casing of the gearbox in more detail, this is formed of welded steel plate sections. The main, or lower, casing 1 consists of two opposed double-walled plate structures 16, each having an inner wall 17 and an outer wall 18 connected by a number of stiffening webs 19. These stiffening webs are shown in broken lines in Figure 5.

It is clear from Figure 1 particularly, that each of the plate structures 16 extends as a unitary member between the bearing of the gearwheel shaft 4 and the bearings of each of the pinions 6, 7 and 8. Each bearing assembly is let into a recess in the edge of the plate structure. Thus the pinion 6 and its bearing assembly 21 are lowered vertically into position in the upper edges of the plate structure to which the bearing assembly is bolted. A separate section 20 of the cover 2 is fixed over the pinion 6 and bearing assembly.

The pinions 7 and 8 are assembled and withdrawn in horizontal directions and again they are located in recesses in the edges of the plate structures 16, the respective bearing assemblies 23 and 24 being bolted to the plate structures and the whole pinion and bearing being enclosed by an inspection cover 25 shown in Figure 2, and, for the pinion 23, in Figure 5.

This arrangement of the pinion mountings is particularly advantageous in cases where it is not possible to withdraw the pinions downwardly, when the gearbox is in position in a ship, because of the upward curvature of the hull immediately aft of the gearbox.

The gearwheel itself is mounted in similar fashion in a central recess in the plate structure, the bearing assembly 26 being bolted to the structure and a plate referenced 'C' on each side of the casing serving to close the recess up to the level of the cover 2.

The situation within the ship may be such that there is insufficient room above the gearbox to lift the gearwheel vertically out of the casing. In this case a modification of the casing is made in that a section of the plate structure, referenced 'B' in Figure 5, is separately removable, as an integral unit, from the main body of the casing. This section B extends from the centre line of the gearwheel up to the cover 2. On removal of section B, the gearwheel can be removed by a small upward movement and then a diagonal movement avoiding any obstructions immediately overhead.

It can be seen that, with or without the separation of section B, the main casing 1 extends between all the shaft mountings, and, being a unitary structure it provides its own jig for determining their relative positions. More important again is that stiffening webs, such as some of those referenced 19, can extend right through the structure from top to bottom (within the double walls of each plate structure 16) without any interruption, such as there would be in a casing which was in several sections and in which the various bearings were separated by more than one section.

The present unitary plate structure is of particular benefit in the context of single helix gears in view of the axial thrusts imparted to the casing. Thus the casing in the region of each pinion is thrust in the opposite direction to that in the region of the gearwheel shaft so that the net effect is to tend to 'dish' the whole casing. Uninterrupted, approximately radial, webs 19 can therefore be employed to resist this effect.

In accordance with the present invention, to increase the rigidity of the casing significantly, the gearbox includes a stiffening plate referenced 'A' in Figures 3, 4 and 5, which extends between and is welded to both plate structures 16. Except for the lowermost portion below the mounting base 27 the plate A extends, laterally (see Figure 3), from the outer wall 18 of one plate structure to the outer wall 18 of the other, and is welded to both walls, and also to the inner walls 17, along the whole of its length in contact with them. This does in fact mean that the inner walls 17 are fabricated from plates welded to opposite faces of the plate A.

The gear casing is closed off, between the plate structures 16, by outside walls 28 independently of the plate A. The plate A does however extend around the gearwheel and forms the outer wall of the casing in the sump portion below the mounting base 27. It

is of reduced width over this portion, extending as it does only between the inner walls 17 of the plate structures 16. As shown in Figure 5, the plate A extends from the mounting base 27 to the top of the main casing adjacent the pinion 6, passing through the region of engagement between the pinion 8 and the gearwheel 5. The engagement of the pinions and gearwheel is accommodated by an aperture in the plate A.

Because of the remoteness of the pinion 6 from the mounting base 27, the axial thrust of this pinion is most troublesome in distorting the gearbox casing with respect to the base 27. The disposition of the plate A, extending from the base to this pinion, is therefore well suited to resist this thrust. Additionally, the lateral extent of this plate, passing *between* the pinion 8 and gearwheel, is much greater than any comparable plate *outside* the pinion 8 (such as the end plate 28) could be, because of the necessity of being able to withdraw the pinion 8 through any such outside plate. The plate A therefore provides two apparently conflicting advantages in that it is a relatively unbroken plate (except for the 'engagement aperture') providing great stiffness, and at the same time it does not prevent assembly or withdrawal of the pinion 8.

The plate A similarly extends between the gearwheel and the pinion 7 although the moment of the distorting forces at that pinion is not so great.

It will be clear that the smallest aperture in the plate A, and thus the greatest strength, is obtained when the plate is tangential to the pitch circles of the pinion 40 and gearwheel. However, a useful advantage is still gained when the plate A is displaced slightly from this position.

**WHAT WE CLAIM IS:—**

1. A gearbox having a single-helix driven gearwheel, a plurality of driving pinions engaging the gearwheel, and bearings for the gearwheel and pinions mounted in two opposing plate structures, each plate structure extending as a unitary member between a bearing of the gearwheel and a bearing of each of said pinions, wherein a stiffening plate, fixed to said plate structures, extends between and parallel to the axes of the gearwheel and a said pinion, said stiffening plate having an aperture to accommodate the engagement of the gearwheel and pinion which engagement would otherwise be obstructed. 50
2. A gearbox according to Claim 1, wherein each said plate structure has two walls rigidly connected by a plurality of stiffening webs. 60
3. A gearbox according to Claim 2, wherein said stiffening plate extends from the outer wall of one plate structure to the outer wall of the other. 65
4. A gearbox according to Claim 1, 2 or 3, wherein said stiffening plate extends around the gearwheel and includes a respective aperture for the engagement of each of a plurality of said pinions. 70
5. A gearbox according to Claim 4, wherein said stiffening plate forms a part of a closure wall of the gearbox. 75
6. A gearbox according to any preceding Claim, wherein said stiffening plate extends from a mounting base of the gearbox to the pinion most remote from said mounting base. 80
7. A gearbox according to Claim 1, 2 or 3 including a respective said stiffening plate associated with each of two or more pinions. 85
8. A gearbox according to Claim 1, wherein said gearwheel and pinions are removable from said plate structures in directions transverse to their axes, means being provided for clamping the gearwheel and pinion bearings in position in recesses in the edges of said plate structures. 90
9. A gearbox substantially as hereinbefore described with reference to the accompanying drawings.

For the Applicants,  
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**1430372 COMPLETE SPECIFICATION**

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Sheet 1

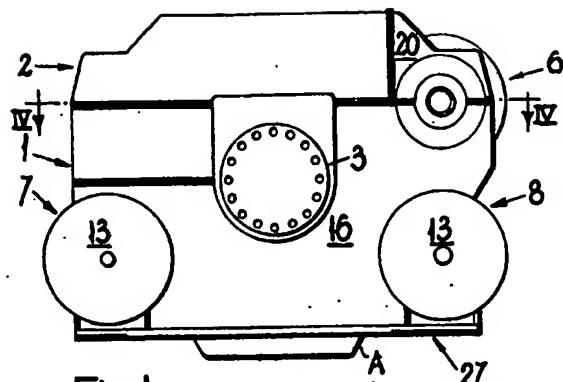


Fig. 1

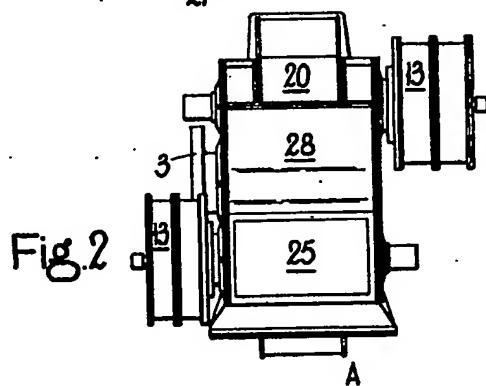
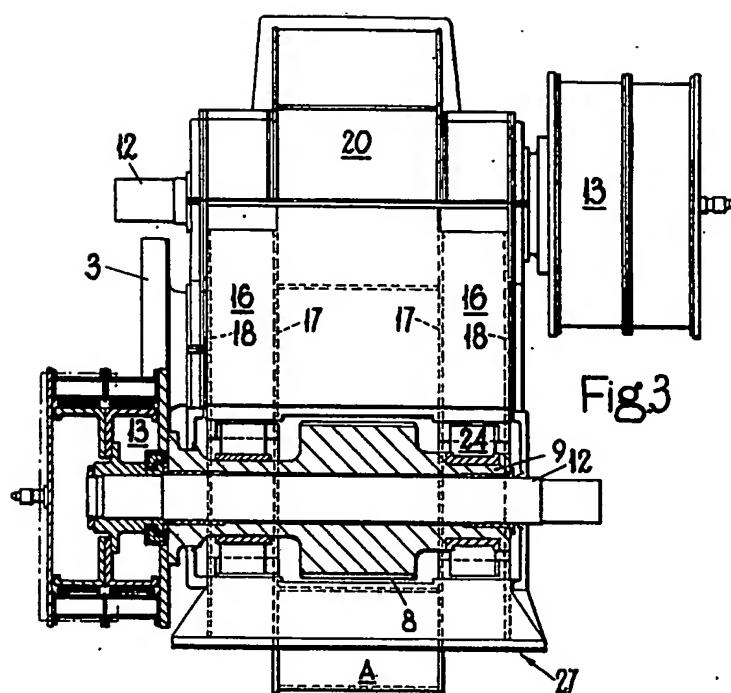


Fig.2

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Sheet 2



1430372 COMPLETE SPECIFICATION

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Sheet 3

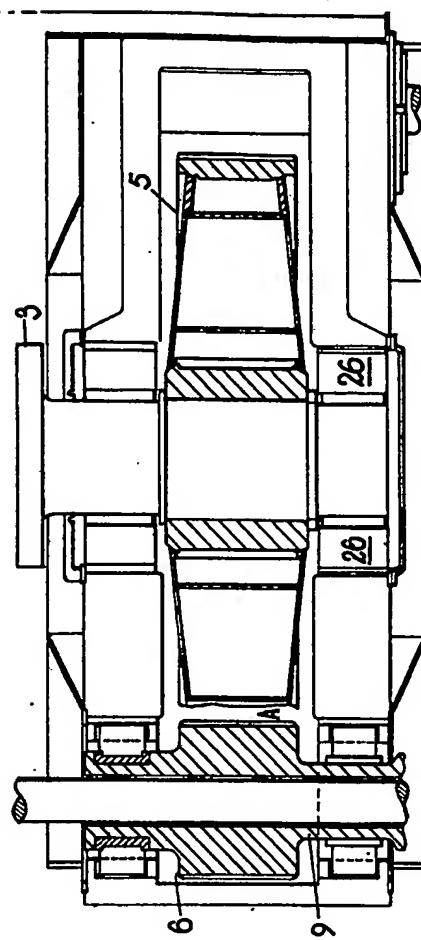


Fig.4

1430372 COMPLETE SPECIFICATION

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Sheet 4*

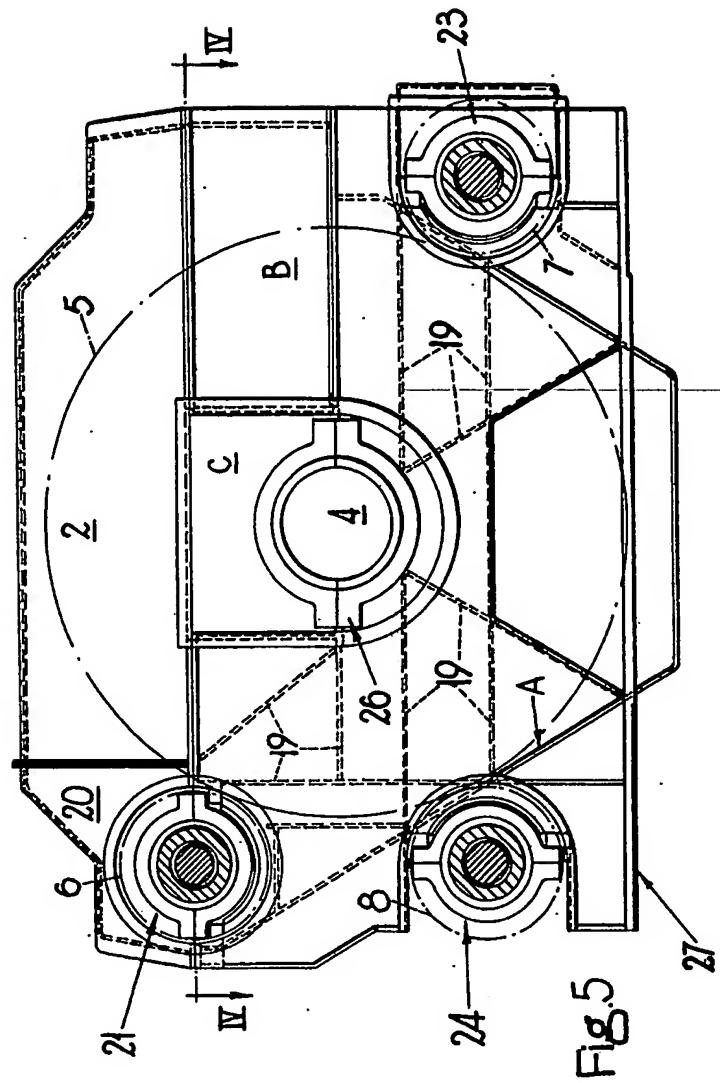


Fig. 5